注意事項：1. 答案一律寫在答案卷上，否則不予計分。
2. 請標明題號依序作答，不必抄題。
3. 計算題需寫出計算過程。

一、單選題：(每題4分，共60分；答錯或不答不給分亦不扣分)

1. In which of the following molecules does the central atom use sp^2 hybrid atomic orbitals in forming bonds? (a) H_2S (b) CS_2 (c) Cl_2O (d) NH_3 (e) SO_2

2. Which of the following is nonpolar, but contains polar bonds? (a) HCl (b) SO_3 (c) H_2S (d) NO_2 (e) SO_2

3. Which of the following series of elements have most nearly the same atomic radius?
(a) Ne, Ar, Kr, Xe (b) Mg, Ca, Sr, Ba (c) B, C, N, O (d) Ga, Ge, As, Se (e) Cr, Mn, Fe, Co

4. The equilibrium constants (K_a) for HCN and HF in H_2O at 25℃ are 6.2×10^{-10} and 7.2×10^{-4}, respectively. The relative order of base strengths is: (a) $F^- > H_2O > CN^-$ (b) $H_2O > F^- > CN^-$ (c) $CN^- > F^- > H_2O$ (d) $F^- > CN^- > H_2O$ (e) none of these

5. As water is heated, its pH decreases. This means that (a) the water is no longer neutral (b) the K_w value is decreasing (c) the water has a lower $[OH^-]$ then cooler water (d) the dissociation of water is an endothermic process (e) none of these

6. Which of the following solid salts should be more soluble in 1.0 M NH_3 than in water? (a) Na_2CO_3 (b) KCl (c) AgBr (d) KNO_3 (e) none of these

7. The compound SiO_2 does not exist as a discrete molecule while CO_2 does. This can be explained because (a) the Si—O bond is unstable (b) the Lewis structure of SiO_2 has an even number of electrons (c) the SiO_2 is a solid while CO_2 is a gas (d) the 3p orbital of the Si has little overlap with the 2p of the O (e) none of these

8. A material is made from Al, Ga and As. The mole fraction of each element is 0.25, 0.26 and 0.49, respectively. This material would be (a) a metallic conductor because Al is present (b) an insulator (c) a *p*-type semiconductor (d) an *n*-type semiconductor

9. The spectrochemical series is

$$I^- < Br^- < Cl^- < F^- < OH^- < H_2O < NH_3 < en < NO_2^- < CN^-$$

Which of the following complexes will absorb visible radiation of the highest energy (shortest wavelength)? (a) $[Co(H_2O)_6]^{3+}$ (b) $[Co(I)_6]^{3-}$ (c) $[Co(OH)_6]^{3-}$ (d) $[Co(en)_3]^{3+}$ (e) $[Co(NH_3)_6]^{3+}$

10. If the reaction $2HI \rightarrow H_2 + I_2$ is second order, which of the following will yield a linear plot?
(a) log[HI] vs. time (b) 1/[HI] vs. time (c) [HI] vs. time (d) ln[HI] vs. time

(背面仍有題目,請繼續作答)

11. A 100-mL sample of water is placed in a coffee cup calorimeter. When 1.0 g of an ionic solid is added, the temperature decreases from 21.5℃ to 20.8℃ as the solid dissolves. For the dissolving of the solid (a) $\Delta H > 0$ (b) $\Delta S_{univ} > 0$ (c) $\Delta S_{sys} < 0$ (d) $\Delta S_{surr} > 0$ (e) none of these

12. Consider the dissociation of hydrogen: $H_2(g) \rightleftharpoons 2H(g)$
One would expect that this reaction: (a) will be spontaneous at any temperature
(b) will be spontaneous at high temperatures (c) will be spontaneous at low temperatures
(d) will not be spontaneous at any temperature (e) will never happen

13. Which of the following is not a structural isomer of 1-pentene? (a) 2-pentene
(b) 2-methyl-2-butene (c) cyclopentane (d) 3-methyl-1-butene (e) 1-methyl-cyclobutene

14. No atoms are lost from starting material in making which kind of polymer? (a) condensation polymer (b) polyester polymer (c) addition polymer (d) vulcanized polymer (e) branched polymer

15. Which of the following is optically active (i.e., chiral)? (a) CH_2Cl_2 (b) 2-chloropropane
(c) 3-chloropentane (d) *cis*-$Cr(en)_2Cl_2^+$ (e) *trans*-$Cr(en)_2Cl_2^+$

二、Write formulas for the following compounds. (8%)

(a) Phosphorus pentachloride

(b) Sodium hydrogen carbonate

(c) Potassium hexacyanoferrate (III)

(d) Ethylamine

三、The equilibrium system $2A \rightleftharpoons 2B + C$ has a very small equilibrium constant: $K = 2.6\times10^{-6}$ mol/L. Initially 3 moles of A are placed in a 1.5 L flask. Determine the concentration of C at equilibrium. (6%)

四、Sulfur will dissolve in an aqueous solution that contains some sulfide ion. Sulfur will then precipitate from this solution if nitric acid is added. Explain this behavior. (6%)

五、(a) The first ionization energy of N_2 (1501 KJ/mol) is greater than the first ionization energy of atomic nitrogen (1402 KJ/mol). Explain.
(b) Would you expect F_2 to have a lower or higher first ionization energy than atomic fluorine? Why? (8%)

六、For a reaction in a voltaic cell both ΔH^0 and ΔS^0 are positive. Will ε^0_{cell} increase or decrease with an increase in temperature? Explain your answer. (6%)

七、Find the number of unpaired electrons for each of the following complex ions: (6%)
(a) $Co(NH_3)_6^{3+}$ (b) $Cr(CN)_6^{4-}$ (c) $Ni(CN)_4^{2-}$